

10/500974

WO 03/056091

PCT/US03/00129

MODULAR GAUGE BLOCK ASSEMBLY WITH SECURE LATERAL PINS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 10/075,645 filed February 13, 2002 which is a continuation-in-part of U.S. patent application Ser. No. 10/038,219, filed January 3, 2002 which is incorporated in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to replaceable self-aligning gauge modules for a tufting machine and is more particularly concerned with gauge modules with individually replaceable gauge elements which can be readily installed and removed.

BACKGROUND OF THE INVENTION

[0003] Tufting machines are built with precision so that the needles and loopers of the machine are accurately spaced from each other along the needle bar or looper bars. The loopers and needles must be spaced from each other so that the looper bills pass closely adjacent to the needles to engage and hold loops of yarns carried by the needles. When assembling a tufting apparatus, errors in positioning these gauge elements may accumulate as the work progresses. The present invention seeks to establish consistency with these parts across the width of the apparatus, to provide a tufting environment, suitable

even for narrow gauge configurations. The present invention also addresses the problem of replacing individual gauge elements that become broken or damaged during tufting. In most modular designs, a broken gauge element requires discarding the entire modular block containing a set of about one to two dozen gauge elements. The present invention allows for quick and efficient replacement of individually damaged gauge elements.

[0004] The idea of replacing individual components of assemblies in tufting machines is not new. In the past, knife holder assemblies have been devised that allow for the replacement of individual knives. The knives were arranged in pre-assembled or modular fashion in a knife holder, each knife holder having a guide mechanism which enabled groups of knives, each group in a separate holder, to be positioned on a carrying member of a tufting machine and maintained in appropriate alignment. U.S. Patent Nos. 4,608,934; 4,669,171; 4,691,646; and 4,693,191 illustrate such prior art knife holder assemblies in which parallel knives are disposed. These prior art knife holder assemblies are then disposed in transverse bars provided with guides for positioning the holders in appropriate positions on a tufting machine.

[0005] Needles have previously been individually secured in modular gauge blocks as shown in U.S. Patent No. 4,170,949, and hooks and knives have also been individually secured in

gauge parts mounting blocks as shown in U.S. Patent No. 4,491,078. These designs have used individual clamping screws to hold each gauge element in place. These blocks were not mated with slots on the carrying members and were heavily machined. In addition, the clamping screws used in these gauge blocks have typically been flat ended and have relied upon the flat tip pushing directly against the gauge element to securely position those gauge elements. When the blocks are machined from relatively soft metals such as aluminum, there has been a tendency for the threads of the block to become worn and allow too much play for all of the screws to securely hold their corresponding gauge elements.

[0006] More recently attempts have been made to incorporate needles and loopers into replaceable modular blocks. U.S. Patent Nos. RE37,108, 5,896,821, 5,295,450 illustrate such modular gauge assemblies in which the gauge elements are permanently embedded into the modular block. The block is attached to the guide bar with a single screw allowing for removal and replacement of the block. One shortcoming of these modular blocks is that when a single gauge element breaks the entire modular block must be discarded.

SUMMARY OF THE INVENTION

[0007] The present invention includes a modular gauge assembly that attaches to a gauge bar. The gauge bar has a

plurality of positioning recesses that allows a detent on an individual modular block to be accurately positioned along the gauge bar. Each modular block typically includes a front surface, a pair of side surfaces opposed to each other, a rear surface opposite to the front surface, and a bottom surface.

[0008] A tongue, which may or may not be a part of the cast block extends from a rear or bottom surface of the modular block. The tongue includes a threaded hole which along with a securing screw serves to mount the block to a gauge bar. The threaded hole aligns with the gauge bar receiving hole when the tongue of the modular block is positioned properly with a recess on the gauge bar. When sufficiently tightened, the securing screw holds the modular block to the gauge bar. Alternatively, the block may be positioned with pins fitting into recesses in the block and gauge bar.

[0009] At least the front surface of the block contains a plurality of spaced parallel slots so that gauge elements may be positioned in the slots with proper spacing. The proximal ends of the gauge elements may have apertures or channels recessed therein. In one embodiment of the present invention the proximal ends of the gauge elements are inserted into the block and secured there by a lateral pin that enters the block on one of the opposing side surfaces and passes through apertures on the proximal ends of the gauge elements. One

alternative embodiment allows the pin to be placed by forming a channel in the block. Another alternative embodiment biases a lateral pin resting in a channel on the proximal ends of the gauge elements by tightening a securing bolt that is in communication with the lateral pin through an opening on the block. The securing bolts may have conical ends or flat ends depending upon their orientation with respect to the lateral pin to exert a wedging or camming force against the lateral pin. In either case the gauge elements are secured by a lateral pin engaging the gauge elements. Individual gauge elements can be replaced by demounting the affected block, removing the lateral pin and removing a selected gauge element. After the selected gauge element is removed a new gauge element may be re-inserted into the proper vertical slot and secured by the lateral pin and securing bolt.

[0010] A plurality of modular blocks are arranged along the surface of the gauge bar and are vertically positioned on the gauge bar by a horizontal surface of the gauge bar or of a guide bar that passes through a guide bar channel on the gauge bar. The width of each block is substantially equal to the distance between the positioning recesses of the gauge bar so that the edges of the blocks abut one another and the blocks are laterally positioned.

[0011] In an alternative embodiment of the present invention each modular gauge assembly attaches to a gauge bar having a plurality of positioning recesses that allows the detent on the individual modular block to laterally position the block on the gauge bar. Each modular block typically includes a front surface, a pair of side surfaces opposed to each other, a rear surface opposite to the front surface, and opposing bottom and top surfaces. The rear surface contains a rectangular tab or detent that includes a threaded hole to receive a securing screw. The threaded hole aligns with the gauge bar receiving hole when the modular block is positioned properly on the gauge bar. When tightened, the securing screw holds the modular block securely to the gauge bar. A plurality of gauge holes extend from the bottom toward the top surface, in some cases passing through the modular block. Gauge elements with proximal ends adopted to be received within the gauge holes may be positioned with proper spacing in the block. Gauge elements that have the proximal end inserted into the block are securely positioned by pin-screws that enter the block below the tab on the rear surface. The pin-screws are positioned beneath the tab. In this fashion, the pin-screws can be accessed without removing the modular block from the gauge bar. When engaging rounded gauge elements such as tufting needles, the pin screws may

advantageously have conical ends to hold the gauge elements by wedging or camming force.

[0012] Of particular advantage is the use of lightweight aluminum alloys such as aluminum 7075 from which to manufacture modular blocks. When these modules are utilized with aluminum alloy or other lightweight material hook bar brackets, jack shaft rockers, and hook shaft drive levers, approximately 40% of the weight of these components, comprising some 200 pounds across the length of a broad loom tufting machine, can be removed from the moving action of the machine. This reduction in weight tends to correspondingly reduce the vibration of the tufting machine and facilitates operation of the tufting machine at higher speeds.

[0013] Accordingly, it is an object of the present invention to provide a tufting machine where the gauge elements of the tufting machine are accurately positioned within a modular block assembly.

[0014] Another object of the present invention is to provide in a tufting machine, a system which can facilitate the rapid change over of one or more damaged gauge elements, reducing to a minimum the downtime of the tufting machine.

[0015] Another object of the present invention is to provide in a modular block assembly, a system which can facilitate the rapid change over of individual damaged gauge

elements, reducing the cost of repairing broken gauge elements and removing the need to replace entire modular blocks when a single gauge element becomes damaged.

[0016] Other objects, features, and advantages of the present invention will become apparent from the following description when considered in conjunction with the accompanying drawing wherein like characters of reference designate corresponding parts throughout several views.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a fragmentary perspective view of a modular block assembly with single looper modular blocks in place on a gauge bar.

[0018] Figure 2 is an exploded perspective view of the modular block assembly of Figure 1 with modular blocks removed from the gauge bar, and one looper modular block disassembled.

[0019] Figure 3 is a perspective view of the rear surface of a modular block of Figure 1.

[0020] Figure 4 is a fragmentary perspective view of a double looper modular block assembly with modular blocks in place on the gauge bar.

[0021] Figure 5 is an exploded perspective view of the modular block assembly of Figure 4, with modular blocks removed from the gauge bar and one block disassembled.

[0022] Figure 6 is a fragmentary perspective view of a modular needle block assembly with modular blocks in place on a gauge bar.

[0023] Figure 7 is an exploded fragmentary perspective view of the modular needle block assembly of Figure 6 with the modular blocks removed from the gauge bar and one block disassembled.

[0024] Figure 8 is a rear perspective view of a modular block of Figure 6.

[0025] Figure 9 is an exploded perspective view of a modular assembly having a single row of loop-pile hooks held in place by a lateral pin and securing bolts.

[0026] Figure 10A is an exploded view of a modular block having a double row of loop-pile hooks held in place by lateral pins and securing bolts.

[0027] Figure 10B is a top perspective view of the relative positions of the gauge elements, lateral pins and securing bolts of Figure 10A when mounted in the block.

[0028] Figure 10C is a bottom perspective view of the relative positions of the gauge elements, lateral pins and securing bolts of Figure 10A when mounted in the block.

[0029] Figure 10D shows in isolation a side elevation view of the relative positions of a single gauge element, lateral pin and securing bolt when mounted in the block.

[0030] Figure 11A is an exploded view of a modular block having cut-pile hooks with lateral pins, and securing bolts.

[0031] Figure 11B is a side elevation view of the block of Figure 11A.

[0032] Figure 11C is a side elevation view of the relative positions of the gauge elements, lateral pins and securing bolt of Figure 11B when mounted in the block.

[0033] Figures 12A and 12B show the mounting of a series of needle modules according to the present invention to a needle bar.

[0034] Figures 12C and 12D are mirror image perspective exploded views of the needle modules utilized in Figures 12A and B.

[0035] Figure 12E is a sectional view of the needle bar in Figure 12A.

[0036] Figure 12F is a perspective view of the needle modules of Figures 12A through E in assembled and unmounted form.

[0037] Figure 13A is an exploded perspective view of an alternative needle module embodiment with an ovular aperture and round lateral pin.

[0038] Figure 13B is a cross sectional view of the needle module of Figure 13A.

[0039] Figure 14A is an exploded perspective view of an alternative needle module embodiment having a round aperture and utilizing a rectangular lateral pin and flat head securing screws.

[0040] Figure 14B is a cross sectional view of the module of figure 14A.

[0041] Figures 15A, 15B, and 15D are cross sectional, front, and bottom views of an alternative needle module for use with two mounting screws and a single set pin.

[0042] Figure 15C is a sectional view of dual needle bars having protruding mounting pins intended to be received in an aperture of a gauge block such as depicted in Figure 15A.

[0043] Figure 16A is a side view of an alternative needle block and gauge element configuration using a flat head set screw and round lateral pin and an oval aperture.

[0044] Figure 16B reflects the hook element and lateral pins and set screw of the modular block of 15A in isolation.

[0045] Figure 17A is a front perspective view of a hook block for a dual needle bar tufting machine according to the present invention.

[0046] Figure 17B is an exploded perspective view of the hook block of Figure 17A.

[0047] Figure 17C is a rear perspective view of the hook block of Figure 17A.

[0048] Figure 18A is a view of lateral pins and conical set screw utilized to position a looper element in isolation from a modular block.

[0049] Figure 18B illustrates the elements of Figure 18A within a modular block according to the present invention.

[0050] Figure 19A is a perspective view of a looper block according to the present invention for a dual needle bar tufting machine.

[0051] Figure 19B is an exploded perspective view of the looper block of Figure 19A.

[0052] Figure 19C is a rear perspective view of the looper block of Figure 19A.

[0053] Figure 20A is a top plan view of a hook that may be used as a gauge element in the modules of the present invention.

[0054] Figure 20B is a side plan view of the hook of Figure 20A.

[0055] Figure 21 is a looper that may be used as a gauge element in the modular blocks of the present invention.

[0056] Figure 22 is an alternative looper design that may be used in the modular blocks of the present invention.

[0057] Figure 23 is a partial sectional view of the business area of a tufting machine.

DETAILED DESCRIPTION

[0058] The present invention is designed for use in tufting machines of the type generally including a needle bar carrying one or more rows of longitudinally spaced needles that are supported and reciprocally driven by a plurality of push rods. In the tufting zone shown in Figure 23, the needles 13 carry yarns 50 which are driven through a backing fabric 114 by the reciprocation of the needles. While penetrating the backing fabric, a plurality of longitudinally spaced hooks 18, 14 cooperate with the needles to seize loops of yarns and thereby form the face of a resulting fabric. In some cases the hooks will cooperate with knives 113 to cut the loops of yarn seized on the hooks and thereby form a cut pile face 146 for the fabric. The present invention is directed to modular units for holding loopers or hooks and for holding needles to facilitate their cooperation during the tufting process.

[0059] Referring in detail to Figure 1, a modular block assembly 5 is illustrated having a single row of gauge elements 10, in this case loopers, housed in a series of modular blocks 15. The individual gauge elements 10 are fastened to each block 15 by a lateral pin 20. As better illustrated in Figure 2, the lateral pin 20 enters the modular block 15 at one of the opposing side surfaces 22a, 22b. The gauge bar 25 and guide bar 30 are used in concert to position the modular blocks 15

relative to one another. The guide bar 30 extends laterally through channel 35 substantially the entire length of the gauge bar 25. The tab breaks 115 of the modular blocks 15 engage with guide bar 30 as shown in Figure 3, to vertically align the individual blocks 15 in the modular block assembly 5.

[0060] Figure 2 illustrates a portion of the modular block assembly 5 with the blocks 15 detached from the gauge bar 25. The gauge bar 25 has a plurality of vertical recesses 40. The recesses 40 are crossed by lateral channel 35 so that guide bar 30 fits between the gauge bar 25 and the rear surfaces 45 of the modular blocks 15. Guide bar 30 creates upper face 31 and lower face 32 which are normal to the side walls of recesses 40. When tab breaks 115 of modular blocks 15 engage these faces 31, 32, the faces serve as restraining surfaces to hold blocks 15 in vertical alignment.

[0061] One modular block 15 in Figure 2 is disassembled and removed from the gauge bar 25 to reveal spaced parallel slots 50 divided by vertical walls 51 located on the front surface 55 of the block for receiving the proximal ends 75 of the gauge elements 10. The illustrated proximal ends 75 of the gauge elements 10 contain apertures such as pinholes 70. When the gauge elements 10 are positioned in the modular block 15 the pinholes 70 align with apertures formed in side surfaces of the block such as pin opening 85. Lateral pin 20 is then inserted

through pin opening 85 in one of the opposing side surfaces 22a, 22b, and the pinholes 70 for each gauge element 10 to fasten the gauge elements 10 in block 15.

[0062] In illustrated modular blocks 15 containing only a single row of gauge elements 10, a tongue portion 60 extends from the rear surface 45 of the modular block 15. The tongue 60 has an opening, preferably in the form of hole 90, as shown in Figure 3. When the modular block 15 is positioned on the gauge bar 25, threaded hole 90 aligns with another hole 100 located in a gauge bar recess 40. Once a modular block 15 is positioned a securing screw 65 can be inserted through hole 90 and tightened into the hole 100 on the gauge bar 25. A modular block 15, once fixed in place by the securing screw 65, is prevented from lateral and vertical movement. The screw 65 and side walls of vertical recesses 40 resist against horizontal movement while the screw 65 and faces 31,32 of the guide bar 30 resist against vertical movement. The fixed position of the blocks 15 insures that the gauge elements 10 remain properly aligned during the tufting process.

[0063] Figure 3 shows the rear surface 45 of a modular block 15 having a single row of gauge elements 10. On the rear surface 45 is a detent in the form of an elongated tab 110 extending vertically from the top 165 of the block to the bottom of the tongue portion 60 of the block. Tab 110 has a horizontal

break 115 that engages with guide bar 30 to vertically position block 15 on the gauge bar 25. The walls of break 115 are preferably substantially planar and parallel so that a part of the rectangular cross section of guide bar 30 closely fits within break 115. The lower segment 120 of the tab contains the opening 90 where the securing screw 65 enters and attaches to a receiving hole 100 in the gauge bar 25.

[0064] Figure 4 illustrates a section of a modular block assembly 5 with three double gauge element modular blocks 130 mounted on the gauge bar 26. Each modular block 130 contains two transverse gauge element rows 125, the forward gauge elements 12 forming a first row 125 and rear gauge elements 11 forming a second row. Modular blocks 130 have two apertures such as pin openings 85a, 85b that are spaced apart on the side surfaces 22a, 22b of the block 130. Unlike blocks 15 in Figure 1, a portion of the double gauge modular blocks 130 rests on top of the gauge bar 26 to vertically position blocks 130. This is accomplished by using a downwardly extending detent such as tongue 60 illustrated near the center of the bottom 135 of blocks 130.

[0065] Figure 5 shows an exploded view of modular block 130 containing two rows 125 of gauge elements 11, 12. The gauge bar 26 in Figure 5 has a plurality of vertical recesses 40. Vertical recesses 40 receive tongues 60 to horizontally

position blocks 130 along the gauge bar 25. Vertical positioning is accomplished by resting part of the bottom surface 135 of gauge blocks 130 on the top surface of gauge bar 25. Modular block 130 in Figure 5 is disassembled and removed from the gauge bar 26 to reveal the spaced parallel slots 50a, 50b located on the front 55 and rear surface 45 of the block 130 for receiving the proximal ends 77, 78 of the front and rear gauge elements 12, 11.

[0066] The proximal ends 77, 78 of the gauge elements 12, 11 contain openings such as pin holes 71, 72 which when positioned in slots 50a, 50b of modular block 130 align with pin openings 85a or 85b, respectively. The lateral pins 20a, 20b are inserted through the pin openings 85a or 85b on one of the opposing side surfaces 22a, 22b and through pin holes 71, 72 in the proximal ends of each gauge element 11, 12 to fasten the gauge elements 11, 12 in the modular block 130.

[0067] In the illustrated modular blocks 130 the tongue portion 60 of the modular block 130 extends centrally from the bottom surface 135. Tongue 60 defines an opening (not shown). When modular blocks 130 are positioned on gauge bar 26, this opening aligns with a threaded receiving hole 100, located in vertical recesses 40 of gauge bar 26. Once the modular block 130 is positioned a securing screw 65 can be inserted through the opening in tongue 60 and tightened into threaded receiving

hole 100. Modular blocks 130, once fixed in place by securing screws 65, are prevented from lateral movement by the securing screw 65 and interface of the detent against walls of vertical recesses. Similarly, modular blocks 130 are prevented from vertical movement by securing screw 65 and interface of bottom surface 135 against the top surface 26a of gauge bar 26. The fixed position of the block 130 insures that the gauge elements 11, 12 remain properly aligned during the tufting process.

[0068] Referring now to Figure 6, another aspect of the present invention depicts a section of a modular block assembly 5 having a row of gauge elements, in this case needles 13, housed in clamping modular blocks 140. Figure 6 shows four clamping modular blocks 140 attached to gauge bar 27. The clamping modular blocks 140 are positioned such that the lower portion 150 of the block 140 extends beneath the gauge bar 27. This exposed lower portion 150 contains individual clamping elements, such as screw-pins 145, shown in Figure 7, that hold the gauge elements 13 in place in the block 140. The gauge bar 27 has a horizontal shelf portion 27a and a vertical portion 27b which join to form an interior right angle into which the blocks 140 are positioned.

[0069] Figure 7 illustrates a portion of a modular block assembly 5 with screw-pin modular blocks 140 detached from the gauge bar 27 and one block 140 disassembled. The gauge bar 27

has a plurality of vertical recesses 40 on the inner surface of vertical portion 27b of the gauge bar 27. As illustrated, the recesses 40 do not extend the entire height of the wall portion 27b of the gauge bar 27. Each recess 40 preferably contains a clearance hole 100 which receives a securing screw 65 to attach blocks 140 to the gauge bar 27. The rear surfaces 45 of modular blocks 140 have a detent such as tab 160 with an opening, such as threaded hole 90 (shown in Figure 8), positioned to align with holes 100, located in the vertical recesses 40 of gauge bar 27. Once a modular block 140 is positioned in the interior right angle between the shelf portion 27a and wall portion 27b, with tab 160 received in a vertical recess 40, the securing screw 65 can be inserted through the corresponding hole 100 in the wall portion 27b into the threaded hole 90 in the tab 160 and tightened to hold the modular block 140 in place. Once fixed in place by securing screw 65, the modular block 140 is prevented from lateral movement by the action of the tab 160 fitting between the vertical walls of the vertical recess 40, by the screw 65. Vertical movement is restrained by action of the screw 65 and the interface of the top surface 165 of block 140 with the bottom of shelf portion 27a of the gauge bar 27. The fixed position of the block 140 insures that the gauge elements 10 remain properly aligned during the tufting process.

[0070] Figure 7 also depicts a disassembled clamping modular block 140 thereby revealing the spaced parallel gauge element openings 155 which extend from the top surface 165 to the bottom surface 135 of the block 140. Openings 155 need not extend completely to the top surface 165 for satisfactory operation, however, it is convenient for manufacture. The individual needles 13 are fastened to the block 140 by dedicated clamps such as screw-pins 145 that fix individual gauge elements 10 within the block 140. Screw pins 145 enter the block 140 at the rear surface 45 of the block 140 on its lower portion 150. When the block is attached to the gauge bar 27 the screw-pins 145 remain accessible so that individual gauge elements 10 can be removed and replaced.

[0071] Figure 8 illustrates the top 165 and rear surface 45 of the block 140. Gauge element openings 155 can be seen on the top surface 165 of the block 140. A rectangular tab 160 for positioning the block 140 on the gauge bar 27 is located centrally on the rear surface 45 of the block 140. The rectangular tab 160 defines the opening 90 which aligns with the holes 100 in vertical recesses 40 and with securing screw 65 fixes the block 140 to the gauge bar 27. Openings 170 for screw pins 145 are located horizontally along the lower portion 150 of block 140.

[0072] Referring now to Figure 9, a preferred embodiment of the present invention depicts a modular block assembly 5 having a single row of gauge elements, in this case loop pile hooks 10, housed in a single gauge modular block 15. The modular block 15 may be mounted and attached to the gauge bar 25 with securing screw 65 extending through the block 15 into the gauge bar 25. The gauge elements 10 are inserted in and removably secured to the block 15 by use of lateral pin 20. The lateral pin 20 may be divided into two or more sections, or be formed of somewhat malleable material, to compensate for various differences in the heights of the gauging elements 10.

[0073] Unlike the previous embodiments, the illustrated lateral pin 20 does not extend through openings in the gauge elements 10, but merely abuts proximal ends of gauge elements 10 so that the gauge elements 10 are resting on the lateral pin 20. The lateral pin 20 is then biased against the gauging elements 10 by a clamp such as securing bolt 38 received in threaded opening 39 on the top surface 165 of modular block 15. Tightening securing bolts 38 biases the lateral pin 20 against the gauging elements 10. In a preferred embodiment the lateral pin 20 is made of a soft metal such as brass so that when urged by the securing bolt 38, the lateral pin 20 deforms slightly and compresses within channels 79 of individual gauge elements 10. As a result of the clamp, the lateral pin 20 is held in place

preventing lateral movement of the pin 20 into or out of the block 15.

[0074] Due to differences in the width of the proximal ends 75 and channels 79 of the various gauge elements 10, varying amounts of pressure are required along the length of pin 20 to sufficiently compress and restrain the gauge elements in a fixed position. Thus a preferred construction divides the pin 20 into segments to prevent the necessity of compressing a single pin 20 into all the gauge elements 10.

[0075] This method of securing gauging elements to a block may also be employed for double gauge modular blocks 130 as seen in Figure 10A. Rear and forward gauging elements 11 and 12 are arranged in parallel transverse rows on block 130. The rear row of gauging elements 11 is held in position by rear lateral pin 20a. Pin 20a is biased against the rear gauging elements 11 by securing bolts 38a which are received by threaded openings 39a. Likewise, the forward gauging elements 12 are held in place by forward lateral pin 20b biased against the forward gauging elements 12 by securing bolts 38b which are received by threaded openings 39b.

[0076] In Figures 10B and 10C, the gauge elements 11, 12 are shown with lateral pins 20a, 20b and securing bolts as they would be positioned in blocks 130, however, the blocks are not shown. Of particular interest is the conical point 89 of

securing bolts 38a, 38b. The conical points 89 are aligned slightly off center of lateral pins 20a, 20b, so that the side wall rather than the vertice of the conical point makes contact with the pins 20a, 20b. This causes a wedge like or camming effect to pressure pins 20a, 20b against gauge elements 11, 12. When securing bolts 38a, 38b utilize camming action rather than mere frontal clamping pressure as would typically be the case if the bolts had flat ends, the bolts 38a, 38b will continue to function even when wear and operating stresses have introduced some play between the threads of the bolts 38a, 38b and their openings 38a, 39b.

[0077] Figure 10D shows a single securing bolt 38a with conical point 89 applying camming type pressure against lateral pin 20a which is engaged in channel 79 of rear gauge element 11. The modular block 130 that would hold these components is not shown so that the interaction of the gauge element, lateral pin 20a and securing bolt 38a can be clearly illustrated.

[0078] An additional embodiment of the invention is illustrated in Figure 11A. The gauge elements, in this case cut-pile loopers 14, 18 are shown removed from block 15. When mounted in block 15, the gauge elements 14, 18 fit between lateral bracing pins 16a, 16b and secured lateral pin 20. The bracing pins 16a, 16b, are slidably press fit within the block 15 and then gauge elements 14, 18 are positioned. Bracing pins

16a, 16b preferably fit in channels 79a, 79b (shown in Figure 11C) of gauge elements 14, 18. Pin 20 is also biased against the gauge elements 14, 18 by a clamping device such as securing bolts 38 proceeding through threaded openings 39 to engage the pin 20. Once the gauge elements 14, 18 are placed in the block 15 and the bracing pins 16a, 16b are positioned in channels 79a, 79b of those gauge elements 14, 18 and lateral pin 20 is in place in block 15, the securing bolts 38 are tightened to bias the securing pin 20 against the gauge elements 14, 18.

[0079] Figure 11A shows a series of four securing bolts 38. In a preferred embodiment, each securing bolt 38 contacts a dedicated segment of the pin 20. Pin 20 may be made of a malleable metal such as brass and either cut or scored to create segments. Thus, pin 20 may be comprised of four separate pieces. The bolts 38 are sufficiently spaced across the block 15 so that each securing bolt 38 can contact a segment of the securing pin 20 and thereby bias between about two and about four individual gauge elements 14, 18. Even without cutting or scoring, the use of a pin of malleable material permits securing bolts to bias multiple gauge elements, which is particularly beneficial in avoiding the need to have apertures for bolts near the edges of the blocks.

[0080] Figures 11B and 11C are side plan views of the modular block 15 and cut pile loopers 14, 18 of Figure 11A,

however, Figure 11C shows the gauge elements 14, 18, lateral pins 16a, 16b, 20, and securing bolts 38 without the modular block 15. It can be seen that cut pile loopers 14, 18 are designed to engage with rear and front rows of needles respectively, although a single length of looper could be used if only one row of needles was to be used to create cut pile tufts. As best seen in Figure 11B, the side wall of conical point 89 exerts camming pressure against lateral pin 20. Lateral pin 20 in turn engages with the proximal ends of gauge elements 14, 18. Figure 11C shows that lateral pins 16a, 16b and 20 are advantageously set in channels 79a, 79b, 79 formed in the proximal ends of the gauge elements 14, 18.

[0081] Turning to Figure 12A, a series of modular needle blocks 240 are mounted to staggered needle bar 227. Each needle block 240 is held in place by one securing screw 265 and two pins 275, each of which penetrates both the needle block 240 and needle bar 227. It will be noted the alignment of the pins 275 and screw 265 is one fourth of the gauge of the block 240 (or one-sixteenth of an inch for a one-fourth inch gauge block) to the left of center of block 240. This results in a one-fourth gauge space 271 at the end of needle bar 227 for the needle blocks 240 aligned on the front of the bar. However, for the needle blocks 240 aligned on the rear of the bar it results in a one fourth guage space 272 where the needle block 240 overruns

the end of needle bar 227. In this fashion, the needles of the front needle blocks are offset a total of one half gauge from the needles of the rear needle blocks, thereby permitting identical needle blocks to be utilized on both sides of the needle bar while providing a staggered orientation for the two rows of needles. In this fashion, a composite one-eighth gauge staggered needle bar is formed from the front and back rows of one-fourth gauge needles.

[0082] More clearly shown in Figures 12C through 12F, the needle blocks 240 of the illustrated embodiment possess two openings 276 to receive pins 275 and a threaded aperture 241 to receive screws 265. In addition, blocks 240 have plurality of threaded apertures to receive preferably flat headed set screws 245 which exert pressure against lateral pin 220. The shaft end 213A of needles 213 is placed through lower aperture 212 across channel 221 and into upper aperture 211. The screws 245 exert pressure against rectangular, and preferably approximately square lateral pin 220 which in turn presses on needle shafts 213A within apertures 211, 212 and securely holds needles 213 in place. The use of rectangular channel 221 to position lateral pin 220 is preferred for manufacturing purposes relative to of the drilling of a round or oval aperture laterally through block 240. To realize the benefits of manufacture, it is not necessary that channel 221 be perfectly rectangular, only that

its upper and lower surfaces be substantially parallel to one another.

[0083] In the alternative embodiment depicted in Figures 13A and 13B, an oval opening 321 proceeds laterally through block 340 and conical set screws 345 are utilized to press round lateral pin 320 against upper needle shafts of 313A while passing from bottom to top of block 340 through apertures 311. The difficulty of forming true apertures 321 rather than channels 221 with an open side, as depicted in connection with Figure 12, as well as the difficulty of utilizing a conical set screw with a range of needle shaft sizes makes the construction of Figure 13 slightly less preferable.

[0084] As shown in Figure 14A a round hole may alternatively be utilized with a square or rectangular lateral pin 220. When a square or rectangular pin is used, a flat headed set screws 245 are advantageously utilized to press pin 220 against upper needle shaft portions 313A. Alternatively, a round pin may also be placed in aperture 322 with acceptable results.

[0085] In the alternative embodiments of Figures 15A through 15D, a block 440 is provided for use with two securing screws 465 and one pin 475 which is received in aperture 476. The pin, which is only optional in the case where a plurality of securing screws are available, extends from needle gauge bar 427 into aperture 476 of block 440. It is to be understood in reference

to needle blocks 440, 340, 240, the aperture 441, 341, 241 is preferably slightly larger than securing screw 465, 365, 265 so that the threads of the screw do not bind with the block and the screw head can exert camming action against the block toward the gauge bar 427, 327, 227. When it becomes necessary to remove the block 440, 340, 240 from the gauge bar, the block may be removed by hand if it does not bind, or if tightly secured by action of pins 475, 375, 275, then a removal bolt having larger threads (not shown) may be screwed into threaded apertures 441, 341, 241 to provide leverage for removal of the block. The threaded section of the larger removal bolt should not even fit into the threaded openings of the gauge bar.

[0086] Figures 16A and 16B illustrate another modular block 540 and the positioning of hook element 14 by pins 516a and 516b, lateral pin 520 and set screws 45. The bottom of gauge element 14 is angled at approximately 7.5 degrees reflected by θ in Figure 16B. This provides an acceptable angle for pressure by lateral pin 520 to securely hold hook element 14 in place.

[0087] Figure 17A through C depict an entire block 540 with both short and long hooks 14, 18 in exploded and front and rear perspective views. It will be appreciated that the blocks 540 may be used either with all hooks of one length in the case of a single row of needles, or with hooks of alternating lengths in

the event that yarns are to be seized from two rows of needles, as might be the case on a staggered needle bar.

[0088] Figures 18A and B disclose another configuration of looper gauge elements 10 utilized in block 640 having lateral pin 620 pressed by conical screw 645 against the angled rear of gauge element 10. Preferably the angle of the gauge element varies from a vertical by approximately 7.5 degrees as represented in θ in Figure 18A. In all events, the angle of the gauge element should be between approximately 5 to 15 degrees.

[0089] Figures 19A through C reflect block 640 utilized with rows of alternating looper gauge elements 10, 12. It will be understood that block 640 may be utilized either with the alternating gauge elements in the case of cooperation with two rows of needles or with a single type of gauge element if the block is to be utilized to seize yarns only from a single row of needles.

[0090] Figures 20 through 22 depict the outlines of gauge elements as well as the approximate 7.5 degree variation represented by angle θ in each instance which permits a lateral pin 20 to securely hold the gauge element in place within a module according to the invention.

[0091] A further substantial benefit of hook and looper modular gauge element assemblies according to the present invention it is their relative light weight. By utilizing

aluminum or other light weight material for modular blocks 240, 340, 440, 540, 640 a substantial weight reduction, on the order of fifty pounds on a broadloom tufting machine, is realized over traditional steel looper and hook assemblies. Furthermore, when other elements of the looper assembly as shown in Figure 23 are also constructed of light weight materials, approximately 40% or over 200 pounds of the looper assembly can be removed from the tufting machine. Thus the modules 240 as well as link arms 137, rocker arms 139, looper arms 134 are all advantageously made of light weight materials such as aluminum alloy. The weights of knife shaft 44 and looper shaft 136 are not so critical as they rotate in place without substantial axial displacement. The resulting reduction of weight in the looper apparatus of the tufting machines substantially reduces vibration and results in smoother operation at high speeds. In addition, it is believed the use of aluminum blocks 240, 340, 440, 540 and 640 assist in conducting heat away from the gauge bars and thereby minimizes thermal expansion of gauge bars and keeps the gauge elements of the tufting machine in better alignment throughout its operation.

[0092] Although preferred embodiments of the present invention have been disclosed in detail herein, it will be understood that various substitutions and modifications may be made to the disclosed embodiment described herein without

departing from the scope and spirit of the present invention as recited in the appended claims.